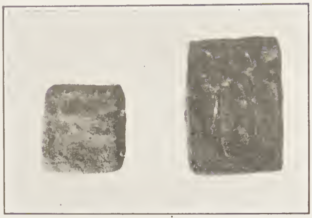
Chinese coins in the collection of Horace Fletcher, San Francisco.

1. Coin of Sung, B. C. 2257; 2, Coin of the Chau, or Chow Dynasty, B. C. 245; 3, 4, 5, and 6, Four coins of the Han Dynasty, A. D. 9.



Egyptian brick money.

Said to have been dug up in Babylonia, purchased in Constantinople in 1885 and submitted in 1898 to Mr. Hormuzd Rassam, assistant to Sir Henry Layard, who pronounced them to be genuine, very ancient, and possibly unique. They had evidently once been jeweled, and were probably taken from some sepulchre. In A. D. 1171, the Fatimite caliphs of Egypt issued similar coins of porcelain and glass, specimens of which are to be found in most of the great coin cabinets of Europe. They are mentioned in Del Mar's "History of Monetary Systems."

Chinese coins in the collection of Horace Fletcher, San Francisco.

7, Half Tael, B. C. 178, Paun Liong; 8, Another of same date; 9. Another dated B. C. 139; 10, Five Chue or Dots, B. C. 139, Ung Chue; 11, Fifty Chue, A. D. 9, Hai-Tshuen; 12 to 18, Seven coins of same period of the "cash" type.

The Evolution of Coins and Coinage Mechanisms

By Alexander Del Mar

The oldest coins (from cuneus, a punch) are assigned by Herodotus to Lydia and by Mionnet to Persia; but if the word is intended to cover cast or hammered metallic money, then coins are 12 or 15 centuries older than the Persian darics; for we have Chinese bronze "knife" coins of Sung, 2257 B. C. inscribed "Tong King Ho," or good for gold, also numerous allusions to metallic money, not weights, but "current money with the merchant," (Genesis xxiii, 16) as the Hindu ramatenkis and siccas, Babylonian brick money, Hyksos ring money (baugs), cowries, and other very ancient testimonies.

These evidences prepare us to trace the metals from which these moneys were made.

The oldest gold mines for which we possess literary evidence are the auriferous of Hyperboria (Thibet) in Herodotus; the oldest by inference are the alluvions of India; the oldest by inscriptions and modern survey are the Bisharee alluvions of Egypt, nineteenth century B. C. A comparison of all the evidences leads to the conclusion that the knife money of China is the oldest of all moneys, the ramatenkis of India, bricks of Babylon, ring money of Egypt, and the punched coins of Asia Minor following successively, in the order of time.

Between the rude issues of Asia Minor and the most perfect coins of the Greek States is an interval of three centuries, during which all that is known, or probably ever will be known, in beautifying a steel die was achieved. So far as design is concerned, the Greek coins were simply perfect. No modern coins can compare with them in beauty.

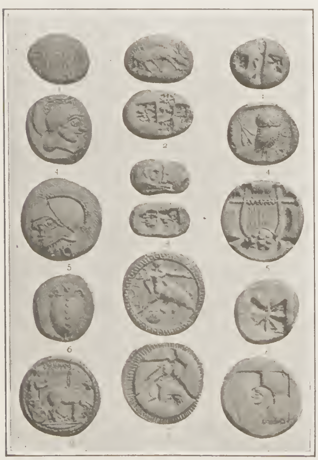
Among the early Roman coins, the ace or æs, Æ, was of cast bronze, the others were of gold, AV, for aurum, or silver, AR, for argent. Though mostly designed by Greek artists, they betray a decadence of the fine arts. The daggers of Brutus and Cap of Liberty on his silver coins are especially interesting. They were struck in the field near Philippi, where he met his fate. On the other hand, the Roman coins evince a practical improvement in the art of coinage; for the designs are surrounded by a line of dots, or a raised circle, to guard against clipping: a Greek invention, popularized by the Romans.

Roman coins of the imperial period are of the greatest historical interest. From the sad and furrowed face of Julius to the self-satisfied effigy of Domitian, extends an interval of 100 years, filled with the most noteworthy events in the history of Rome.

With the removal of the capital to Byzantium (Constantinople) began that rapid decline in the arts characterized by the "Dark Ages" and feudal system; the coinage faithfully reflecting it: for the arts cannot flourish in serfdom or slavery.

This decadent period lasted until the Arabian Renaissance of the twelfth and Italian Renaissance of the fourteenth century afforded, through the agency of commerce, encouragement to the arts.

The discovery of America and its influence in ameliorating the social condition of Europe is the greatest event in the history of the world. In little more than

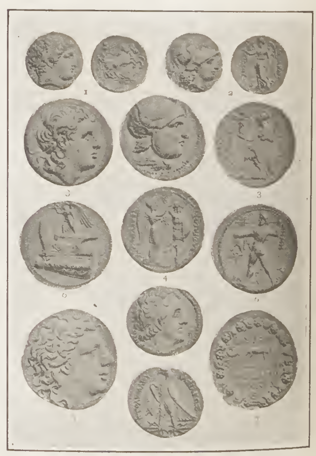


Early Greek coins, B. C.

1, Ionia (El.); 2, Ephesus? (El.); 3, Crœsus (A. V.); 4, Athens (A. R.); 5, Calymna (A. R.); 6, Aegina (A. R.); 7, Tarentum (A. R.); 8, Syracuse (A. R.).

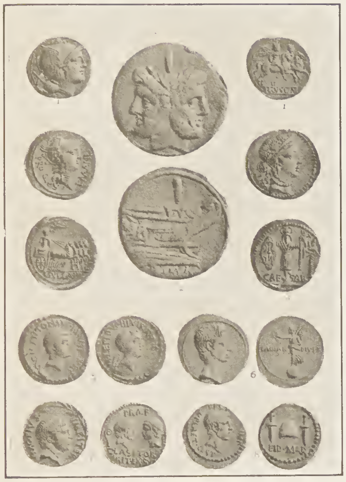
Greek coins. Five periods, B. C. 480-400.

1, Terina (A. R.); 2, Thurium (A. R.); 3, Elis (A. R.); 4, Tarentum (A. V.); 5, Amphipolis (A. R.); 6, Syracuse (A. R.).



Historical Greek coins.

1. Philip of Macedon; 2, Alexander the Great; 3, Lysimachus of Thrace; 4, Seleucus I of Syria; 5, Ptolemy I; 6, Demetrius Poliorcetes of Macedon; 7, Mithradates.



Roman Republican coins.

1, Denarius (A. R.); 2, As (A. E.); 3, Sulla (A. V.); 4, Julius Cæsar (A. V.); 5, M. Antony and M. Lepidus (A. V.); 6, Octavian (A. R.); 7, Sextus Pompey, Pompey the Great and Cneius Pompey (A. V.); 8, Brutus (A. R.).

The twelve Cæsars.

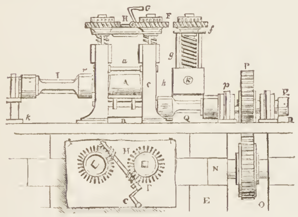
1, Julius Cæsar; 2, Augustus; 3, Tiberius; 4, Caligula; 5, Claudius; 6, Nero; 7, Galla; 8, Otho; 9, Vitellius; 10, Vespasian; 11, Titus; 12, Domitian.

Anglo-Saxon coins.

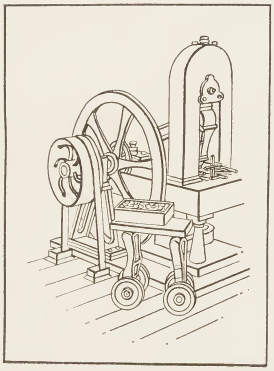
1, VIII Century Sceat; 2, Offa of Mersia; 3, Aethelberht of East Anglia; 4, Wigmund, Archbishop of York (gold); 5, Alfred of Wessex; 6, Halfdan; 7, Olaf Quaran; 8, Edward the Elder; 9, Aethelred II; 10, Edward the Confessor.

a single century, 1540-1650, were made nearly all the great discoveries in science and art which afford the basis of our existing industries, scientific attainments, and mechanical inventions. Here again the coinage reflects the revolution. Compare the pennies of the Normans with the Italian effigies of Mary and Elizabeth; or the groats of Henry VI with the guineas of Charles II.

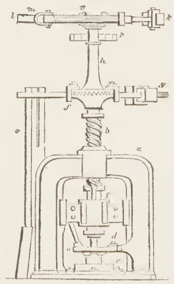
This brings us from coins to coinage; from the fine arts to mechanisms. Leaving cast coins, and brick and ring moneys, out of view, the ancient method of making a coin was to hammer out a thin plate of metal, cut it into circular disks with the shears, and strike it with a steel punch, incused with a design; the blow



Rolling mill for "flatting" metal for coining.



Embossing press for stamping the designs on coins.



Press for punching coin blanks.

English silver coins.

1, William I, penny; 2, Henry I, penny; 3, Edward I, penny; 4, Henry VI, groat; 5, Henry VII, shilling; 6, Elizabeth, sixpence; 7, Charles I, half crown.

English gold coins.

1, Henry III, gold penny; 2, Edward III, noble; 3, Henry VI, angel; 4, Henry VII, sovereign; 5, Charles II, guinea.

English historical medals.

1, Mary, Queen of Scots, by Primavera; 2, Elizabeth, Badge—Defeat of Armada.

being delivered by hand, in much the same way that we would now put a punch mark upon a metal plate. The coin was then finished with a file. The next improvements were to roll the metal between two small cylinders, so as to produce a plate of uniform thickness, and to cut it into disks with a punch. At this point invention stopped and retrograded for practically a thousand years, during which time the population of Europe declined from 120 to 40 millions, and commerce retrograded to barter, or to payments in kind.

The metallic plunder of America was the tremendous lever that converted the decay of Europe into an era of progress. In the fifteenth century a skilled coiner, of whom there were but few, might be able to turn out by hand 50 or 60 coins a day; a result totally inadequate to cope with the vast quantity of treasure, chiefly silver, that shortly began to arrive from America. To multiply coiners was to multiply forgers; and thus the coining machine became a necessity of State. A laminating mill and screw coining press was invented in Italy, 1547; Spain, 1548; France, 1553; England, 1561, reign of Elizabeth.

After several trials and abandonments the mill and press were established permanently under Charles II, whose golden guineas, struck in 1662, were the first regular issues of machine coins made north of the Channel.

The laminating machine is sufficiently explained in the illustration showing the rolling mill (page 121), where a sheet of metal is made to pass between rollers *A* and *B*, which reduce it to a uniform thickness. Circular disks, exact size of the coin to be made, are then punched out by the machine.

Finally the disks are submitted to a double punch, the upper one being a steel die incused with the obverse, and the lower one incused with the reverse of the coin to be produced. When subjected to this double process, with a pressure of 50 to 75 tons, the inert disks, no matter what their commercial value, are transformed into money, with the legal value conferred upon them by law. The double punch constitutes the seal of the State; and it is that, and the mint law behind it, which converts metal into coins and coins into the "dollars" or other monetary denominations described in the legal-tender law.

ermination of Plant Relationship by Means of Serum

A Means of Investigating Origins by a Comparison of Albumens

The problem of every system of classification, whether zoological or botanical, is such arrangement of the organisms that their historical development from their origin down shall be presented as clearly as possible. The classification of animals and plants in a natural system is to some degree the indication of the ratio of relationship of the individual species to common ancestors. As, however, all judgments in regard to the construction of a system of classification rest upon subjective perception of similarity and disparity between the objects contemplated, various attempts have been made of late to use similarities other than those formerly held to be important as a basis for the natural system, or as the reason for changes in it, or even for overthrowing it. In any case its divisions are capable of change, and it is only the older botanists who looked upon the system as a fixed series of pigeon-holes for the accommodation of their discoveries in the vegetable kingdom. This elder generation, though, has passed away. The history of evolution teaches that there is a progressive differentiation. Far greater uncertainty exists, however, in the classification of the individual groups, because consanguinity cannot always be traced with certainty on account of morphological conditions, and so there is no doubt that even to-day we are still far from being able to regard our "natural" systems as final.

The necessity of making every possible effort to place systematology, especially that of the higher plants, on a better basis has led to investigations with the aid of the serum diagnosis. In discussing in the *Umschau* this method of determining the classification of plants, Dr. Kurt Gohlke says:

"The methods of this diagnosis by means of serum have become very important of late years, for the most widely separated branches of science. Uhlenhuth has been able to prove not only that the blood of one animal can be distinguished from that of another by the aid of serum reactions, but also that the relationships of the different kinds of blood can be determined. Especially interesting are the results which Uhlenhuth, Wassermann, and Stern were able to prove concerning the connection between human blood and that of the various species of apes, thus establishing 'consanguinity' by means of sero-biological methods.

"Most interesting for the natural sciences was the proof offered by Kowarski that vegetable albumen also could be determined by means of a diagnosis with serum. Various experiments were made on this point, one of which was that of Magnus and Friedenthal, who were able to show a relationship between truffles and yeast fungus."

Any discussion of a natural relationship presupposes, however, a preliminary investigation as to whether this relationship of the albumens is to be regarded as equivalent to the natural relationship. When we consider the important part played by chemical processes in the life of every organism, it can probably be assumed with certainty that the close or distant relationship between two organisms in the great ancestral stock of the organic kingdom will also be evident in their chemical properties. This natural relationship must also of course be evidenced in the structure of the highly concentrated albumen which is so closely connected with the vital functions. The composition of these albuminous substances is not known. At any rate it is not possible, at least by chemical means, to determine them so exactly that this determination would suffice for the purposes of classification. It has, however, become possible, as has been said before, to secure a differentiation of albumens by the aid of serological investigation.

"Before, however, I enter into the particulars of the various methods in question," continues Dr. Gohlke in pursuing his subject, "I should mention that the utility of these methods for special botanical purposes had to be proved. The proving of this utility became absolutely necessary after the publication of the experiments previously made, some of which were decidedly fragmentary and were not undertaken for the purpose of systematic grouping in families, while others yielded contradictory results.

"To this end, four methods were tried, namely, precipitation, the binding of the complement (Wassermann's reaction), anaphylaxis, and conglutination."

For the botanist probably anaphylaxis (hypersensitiveness) had to be excluded as a matter of course. The method of using it is the following: "If foreign albumen is introduced, as by inoculation, into the body of a warm-blooded animal, there is developed after awhile, and after the introduction of a certain amount of the inoculating material, a peculiar sensitiveness. This hypersensitiveness is evidenced in this way: that the animal thus treated reacts with violent symptoms of illness, and often dies in a few minutes if inoculated again with the same solution of albumen, even when this contains no poison. The condition called anaphylaxis has, therefore, a strictly specific effect, that is, rabbits previously treated with horse serum are only hypersensitive to this and not to goat or bovine serum. Relationships, though, can be recognized."

As the albuminous solutions with which botany is concerned are obtained almost entirely from the seed of plants, and as the solutions vary greatly in the amount of albumen they contain, each depending on the albuminous content of the respective seed, an exact judgment as to the experiments made by anaphylaxis is, therefore, difficult. Any positive judgment becomes impossible when it is remembered that a large amount of other substances, some poisonous (as alkaloids) are contained in the solution, which substances must be injurious to the animal. Besides, the undue proportion of deaths among the animals used for the experiments condemns the use of the method in proving relationships in a botanical classification.

"Without going into the method of binding the complement, which is that of Wassermann's reaction used in the investigation of syphilis," says our writer further, "I wish to reject it as also unsuitable for the present purpose. The results of this method are extremely exact and clearly defined, but are too specific for the end in view. It is easy by the aid of this method to determine the albumen (antigen) used for the inoculation, the reaction also appears if the albumen belongs to another closely allied species, but it fails for more distant relationships. For a system of classification, though, it is important to be able to prove very distant relationships, consequently to obtain a remote reaction."

The two other methods, precipitation and conglutination, are well suited for obtaining reactions showing connections. Precipitation is extremely simple, and requires only an antigen and an immune serum produced by this antigen. This immune serum is obtained as follows: An albuminous solution (as an extract of the albumen of beans) is injected into the circulation of a rabbit. After a number of injections, when the rabbit's blood is drawn off and coagulates, the serum which separates forms the immune serum. This immune serum has the characteristic that in clearly defined gradations of dilution up to a certain degree it gives a precipitate with the antigen used for injection, that is with the bean albumen, but it does not give a precipitate with an albuminous solution of other origin. This assertion, however, cannot be pushed too far. This specific reaction appears only when the albuminous solutions, that is, the albuminous solution used for injection and the second albuminous solution, do not come from related seeds. Thus, for instance, an immune serum produced by means of a papilionaceous plant, the lentil, reacts upon all other papilionaceous plants and further upon the related rose and crowfoot families, but, on the other hand, it does not affect a single plant of another more distantly allied family (as the grasses). The first experiments for a reaction showing relationships were made by this method. Besides its simplicity, precipitation has for botany another great advantage over other methods, namely, it brings to view not only connections with other families of the same series far beyond the family with which it starts, but what is still more important it shows connections with other series also.

"Conglutination," according to Dr. Gohlke, as he explains how to use the immune serum in testing the albumen of seeds, "is somewhat more difficult in its technical details, as when it is employed, the serum of a ruminant (for instance, bovine serum) is used. If in the method by precipitation we had to do with the graduated dilution of the albuminous solution in various test tubes (1 to 200, 1 to 400, etc., up to 1 to 50,000), in the method by conglutination the amount of albumen in the extract is constant in all the test tubes (the dilution might be 1 to 200), and the variation is only in the amount of immune serum that is added to it. The proportion of serum in this method is exceedingly small (0.08, 0.02, 0.01, 0.005 cubic centimeter in test tubes Nos. 1 to 4, while in the precipitation method each glass receives 0.1 cubic centimeter). In the conglutination method the extract and the immune serum are combined at 37 degrees in two hours in the incubator, that is, the extract is sensitized. After this period of time, fresh bovine serum is added in the proportion of 0.4 cubic centimeter for each tube. There then appears in those tubes where a large amount of the immune serum is present a clearly evident conglutination, that is, a flocculent precipitation, which is entirely different from the deposit of the precipitation method. This characteristic clumping rests on this fact, that bovine serum contains some substances which are called conglutinins and which produce conglutinations. The advantages of this method consist in the ideal sensitiveness which essentially exceeds that obtained by precipitation, and in the small amount of immune serum it is, on this account, necessary to use. This permits hundreds of experiments to be made in all directions in the vegetable kingdom from one original immune serum. A necessary condition is, however, that the immune serum should be of highest potency."

This brings us to a very important point. The amount of albumen contained in the extracts of albumen gained from the seed of plants varies so greatly that it is much more difficult to immunize the rabbit than it is to immunize blood in analogous experiments in hygiene or zoology.

The seeds in Dr. Gohlke's experiments were crushed to a very fine meal in mortars or in the mill, which work demanded naturally extreme cleanliness. The meal was then mixed in definite proportions with a solution of common salt, and some time was allowed for extraction. The solutions of albumen thus obtained were cloudy and were filtered until clear.

There appeared during this process the collateral phenomena characteristic of vegetable seed. Various substances were found which are supposably injurious to the animal if injected, and which would even cause death. Although the most varied experiments were made for the removal of these injurious substances, these experiments were not always successful in getting rid of all of them. Consequently, in discussing the utility of the albumens to be used in the experiment, a preliminary investigation as to whether these injurious substances are present in the albumen must be assumed. On this account the preparation of the extract varies according to the specific character of each seed.

Occasionally a potent immune serum is obtained after three or four injections, 10 cubic centimeters being used for each injection. There are, though, cases in which no immunity was attained after frequent injections. The reason for this is either in a distinctive peculiarity of the animal, for Uhlenhuth mentions that, for instance, of ten animals treated at the same time with albumen only one yields a potent immune serum, or else the difficulty arises from too small a content of albumen in the extract. This